Tualatin Basin Goal 5

Program Implementation Report

Draft 2 Issue Paper #1:

Approaches and Methods to Develop and Encourage Habitat Friendly Development Practices

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Tualatin Basin Steering Committee

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Approaches and Methods to
Develop and Encourage Habitat Friendly Development Practices

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A. INTRODUCTION

Background and Purpose

On September 29, 2005 the Metro Council voted to approve a regional Nature in Neighborhoods (Goal 5) program. This council action incorporated the *Tualatin Basin Fish & Wildlife Habitat Program*, as developed and recommended by the Tualatin Basin Partners for Natural Places (Partners). Under an intergovernmental agreement between the Partners and Metro, applicable elements of the adopted Basin program are required to be implemented within one year following the Metro Council's final decision (or within 60 days of LCDC's acknowledgement of Metro's Functional Plan provisions, whichever is later).

Applicable elements included compliance with the six steps identified in Section B of Chapter 7 of the *Tualatin Basin Fish & Wildlife Habitat Program.* One of these steps is the development of a model Low Impact-Development (LID) ordinance for the basin, which would provide tools designed to reduce environmental impacts of new development and removing barriers to their utilization. This step includes local adoption of LID guidelines. In addition, Basin jurisdictions must adopt provisions that facilitate and encourage the use of habitat-friendly development practices, where technically feasible and appropriate, in all areas identified as Class I and II riparian habitat areas.

An important feature of the Basin program is the encouragement of land developers and property owners to incorporate habitat friendly practices in their site design. *Habitat friendly development practices* include a broad range of development techniques and activities that reduce the detrimental impact on fish and wildlife habitat relative to traditional development practices. As shown in Table 1 below, Metro has identified a wide range of habitat-friendly development practices that represent best management practices. While the phrases are sometimes used interchangeably, for the purposes of this paper *low impact development (LID)*, which is more specifically focused on minimizing hydrologic impacts, e.g., reducing *effective impervious area (EIA)* and improving water quality, is considered a subset of habitat friendly practices.

The primary objective of this Issue Paper is to begin to identify those approaches and methods which could be successfully used within the Tualatin Basin to develop and encourage habitat friendly development practices. The potential benefits and challenges associated with each approach (including any technical issues and/or regulatory barriers) are noted. Some approaches may conflict with current locally adopted regulations, which may necessitate modification of the approach or a modification of local ordinances before they can be implemented. The importance of removing barriers from existing regulations in order to enable the use of these types of approaches was

highlighted in the Audubon Society of Portland's 2004 *Stormwater/Pavement Impacts Reduction (SPIR) Project Report*.

The Basin jurisdictions currently implement many practices which reduce the detrimental impact of development on fish and wildlife and these will be discussed and detailed for each jurisdiction in an appendix to this document. As demonstrated under each approach explored, not all approaches are appropriate for all areas of the Tualatin Basin. Also, some methods may not be appropriate to implement together, as their combined effect may actually be detrimental. All approaches, both currently used and possible future practices, must consider specific topographic and soil constraints, and be evaluated for safety, effectiveness, longevity, and maintenance costs. The list of approaches and methods is not exhaustive, but is intended to highlight practices that have been used successfully in the Portland metropolitan region and could have limited or broad applicability in the Tualatin Basin.

Within the Tualatin Basin, the following concerns have been noted relative to the practices listed in Table 1:

- Infiltration and groundwater recharge practices will need to address DEQ / UIC standards;
- The potential implementation of infiltration / groundwater recharge practices in the Tualatin Basin will be subject to local soils and groundwater conditions;
- Stormwater 'pollutants' are identified and regulated under existing MS4 permits in the Tualatin Basin.

Table 1

Habitat-friendly development practices (Urban Growth Management Functional Plan Table 3.07-13c.)
Part (a): Design and Construction Practices to Minimize Hydrologic Impacts
1. Amend disturbed soils to original or higher level of porosity to regain infiltration and stormwater storage capacity.
2. Use pervious paving materials for residential driveways, parking lots, walkways, and within centers of cul-de-sacs.
3. Incorporate stormwater management in road right-of-ways.
4. Landscape with rain gardens to provide on-lot detention, filtering of rainwater, and groundwater recharge.
5. Use green roofs for runoff reduction, energy savings, improved air quality, and enhanced aesthetics.
6. Disconnect downspouts from roofs and direct the flow to vegetated infiltration/filtration areas such as rain gardens.
7. Retain rooftop runoff in a rain barrel for later on-lot use in lawn and garden watering.
8. Use multi-functional open drainage systems in lieu of more conventional curb-and-gutter systems.
9. Use bioretention cells as rain gardens in landscaped parking lot islands to reduce runoff volume and filter pollutants.
10. Apply a treatment train approach to provide multiple opportunities for storm water treatment and reduce the possibility of system failure.

11. Reduce sidewalk width and grade them such that they drain to the front yard of a residential lot or retention area.
12. Reduce impervious impacts of residential driveways by narrowing widths and moving access to the rear of the site.
13. Use shared driveways.
14. Reduce width of residential streets, depending on traffic and parking needs.
15. Reduce street length, primarily in residential areas, by encouraging clustering and using curvilinear designs.
16. Reduce cul-de-sac radii and use pervious vegetated islands in center to minimize impervious effects, and allow them to be utilized for truck maneuvering/loading to reduce need for wide loading areas on site.
17. Eliminate redundant non-ADA sidewalks within a site (i.e., sidewalk to all entryways and/or to truck loading areas may be unnecessary for industrial developments).
18. Minimize car spaces and stall dimensions, reduce parking ratios, and use shared parking facilities and structured parking.
19. Minimize the number of stream crossings and place crossing perpendicular to stream channel if possible.
20. Allow narrow street right-of-ways through stream corridors whenever possible to reduce adverse impacts of transportation corridors.

Part (b): Design and Construction Practices to Minimize Impacts on Wildlife Corridors and Fish Passage

1. Carefully integrate fencing into the landscape to guide animals toward animal crossings under, over, or around transportation corridors.
2. Use bridge crossings rather than culverts wherever possible.
3. If culverts are utilized, install slab, arch or box type culverts, preferably using bottomless designs that more closely mimic stream bottom habitat.
4. Design stream crossings for fish passage with shelves and other design features to facilitate terrestrial wildlife passage.
5. Extend vegetative cover through the wildlife crossing in the migratory route, along with sheltering areas.

Part (c): Miscellaneous Other Habitat-Friendly Design and Construction Practices

1. Use native plants throughout the development (not just in HCA).
2. Locate landscaping (required by other sections of the code) adjacent to HCA.
3. Reduce light-spill off into HCAs from development.
4. Preserve and maintain existing trees and tree canopy coverage, and plant trees, where appropriate, to maximize future tree canopy coverage.

Format of Issue Paper #1

The following sections describe various approaches that could be used to encourage habitat friendly development. The ten approaches presented in this paper are divided into three general categories:

- Planning and development. These approaches include methods that are typically associated with land use planning and development reviews.
- Engineering and design. These approaches include methods that typically require a more innovative approach to engineering and may require the adoption of new design specifications and public works standards. These approaches may require detailed geotechnical analysis and design for on-site soil suitability and slope stability. Within public rights-of-way, how these approaches affect emergency response access, utility access, roadway structure, and road maintenance costs will require careful evaluation.
- Building design. This approach includes methods that affect the building itself and may necessitate modifications to the building and/or plumbing code.

For each of the approaches described in this paper, information is provided in the following format:

- A brief description of the various methods typical of the approach,
- The potential benefits and challenges associated with implementing the approach,
- A preliminary recommendation for the Tualatin Basin, and
- Examples and references of how the approach has, or might be, used.

In addition, at the beginning of each section, the answers to the following key questions are summarized:

- **?** Does the approach "Help avoid and/or minimize impacts?" *Tools that help to avoid the intrusion of development into habitat areas to the extent practicable are the preferred. When impacts cannot be avoided, the use of tools that help lessen or minimize detrimental impacts to the extent practicable should be encouraged.*
- **?** Is the approach "Applicable basin-wide or adjacent to resource area?" *Some practices could be effective anywhere within the basin; others are only effective within or adjacent to habitat areas.*
- **?** Are "New or amended regulations required" to implement the approach? *In some cases implementing a practice would require new regulation to be effective; in others existing regulations may be sufficient or a non-regulatory approach is sufficient.*
- **?** Does this approach provide "Tools to reduce effective impervious area (EIA)?" *Reducing EIA provides direct benefits to water quality and in-stream and streamside habitat through stream flow moderation, reduced frequency of flooding. Some, but not all, habitat-friendly practices will help reduce EIA.*
- **?** Is the approach "Recommended for basin?" *Some practices may be particularly recommended for use in the Tualatin Basin; others may be less useful due to regulatory or locational constraints.*

B. PLANNING AND DEVELOPMENT APPROACHES

Planning and development approaches include those methods that can be implemented most easily at the time of land use approval, e.g., as part of a subdivision or development review. With the possible exception of the use of pervious materials within parking areas, these methods do not require any engineering innovations or new specifications. Many jurisdictions in the Tualatin Basin employ some, or even most, of these tools. For example, since 1974, Washington County has preserved flood-prone areas within easements and non-buildable tracts, which has resulted in much of THPRD's parkland. However, in some cases, it may be necessary for jurisdictions to modify their development ordinances in order to enable the use of specific approaches.

The planning and development approaches considered in this section include the following:

1) Land Division Design
   - Methods include clustering/lot size averaging and on-site density transfers

2) Site Design
   - Methods include increased flexibility for setbacks, lot coverage, building heights

3) Parking Design
   - Methods include reduced parking ratios, shared driveways and parking areas, increased parking lot landscaping, smaller car spaces and stall dimensions, increased use of pervious materials

4) Landscaping/Hardscape Design
   - Methods include locating landscaping adjacent to habitat areas, increased use of native plant, improved soil amendment, reduction of non-ADA sidewalks within a site, increased use of habitat-friendly fencing, preservation of existing trees, maximize forest canopy

5) Lighting Design
   - Methods include re-directing outdoor lighting and reducing light spill-off

6) Density Reduction for Regionally Significant Habitat
   - Methods include modifying definition of net buildable areas, establishing reduced minimum buildable lot sizes

1. Land Division Design

Key Questions	
Help avoid or minimize impacts?	*Both, but primarily these methods allow developments to avoid habitat areas.*
Applicable basin-wide or adjacent to resource area?	*Effective on sites adjacent to resource area; however, may have "smart development" benefits basin-wide.*
New or amended regulations required?	*Some codes may have to be amended to allow increased flexibility in lot size averaging and density transfers. Could be provided option rather than requirement for developer.*
Tools to reduce effective impervious area (EIA)?	*No, unless combined with other "green" design and development approaches.*
Recommended for basin?	*Yes, only for properties which include resources.*

Description of Methods (Lot Size Averaging and Transfer of Density)

Zoning and land division ordinances can require, allow, or encourage lot size averaging at the land division stage to avoid or minimize impacts to significant riparian and habitat areas. Lot size averaging is typically most relevant for residential land divisions, but the method could also be applicable in commercial and industrial zones that establish minimum lot sizes. These techniques are generally implemented through local Planned Development (PD) or Planned Unit Development (PUD) review options.

Rather than specify a minimum lot size for every lot in a land division (such as 8,000 square feet), lot size averaging could allow a combination of smaller and larger lots, with an overall average lot size of 8,000 square feet. Another approach could be zoning that establishes the overall maximum number of units per gross acre, and allows a mix of lot sizes to achieve that overall density. Significant riparian and habitat areas could also be set aside and protected in an open space tract (dedicated to a public agency or owned by a homeowners association), with an allowance for the remaining lots to be smaller than the specified minimum lot size to achieve the overall average density. However, it should be noted that creating open space tracts may have implications for enforcement and the related costs for long-term maintenance.

Ordinances could also allow or encourage transfer of development potential from constrained portions of a site to non-constrained portions. This method is commonly used to permit transfer of development potential from floodplain and wetland areas to upland areas. The tool is less

commonly used to transfer density from upland habitat areas. On-site density transfers can be implemented through a land division or site plan review process (for example, multifamily projects that do not involve a land division). For residential projects, on-site density transfers typically require lot size averaging or clustering of units on a smaller portion of the site. Ordinances can provide incentives for density transfers, such as "bonus" density or permitted flexibility on lot sizes, setbacks, street widths, and landscaping standards. The density transfer provides a tool to protect significant riparian and habitat areas through dedication, an open space easement or tract or deed restriction.

Benefits and Challenges

A. The lot size averaging and density transfers can provide benefits, including the opportunity to avoid impacts on significant resource areas, and create neighborhoods that are responsive to natural features. In addition, there may be non-habitat related benefits such as the potential for a broad mix of lot sizes and associated housing types and sizes and varied development patterns.
B. Developers could be reluctant to pursue lot size averaging or density transfers if they make the land division review process more complex, time-consuming, or vulnerable to appeal. For example, in jurisdictions where lot size flexibility is accomplished through the planned unit development process, requirements such as minimum development size, larger open space dedications, increased submittal requirements and, subsequently, longer processing times, will limit the use of this method.
C. Smaller lots with shared open space may be seen by some developers as less marketable than traditional subdivisions.
D. Most of the development in the urbanized portion of the Basin is now limited to relatively small-scale redevelopment and infill projects, which may reduce potential opportunities for (and benefits of) transferring density.
E. In infill settings, surrounding property owners could be resistant to smaller lot sizes or clustered homes, even if the overall average density is maintained. Buffers may be required to mitigate impacts. Ordinances may also limit certain housing types (such as attached or multifamily units) in particular zones.
F. Allowing lot size averaging and density transfer by right (subject to clear and objective standards) may help encourage preservation of the resource, but may be seen as conflicting with a jurisdiction's objectives for community involvement and citizen participation.
G. Minimum density requirements can conflict with objectives to protect significant riparian and habitat areas. Unless a development site is quite large, there may not be enough area to effectively accommodate the on-site density transfer in a manner that is compatible with surrounding developments and marketable for the developer *(see discussion of Density Reduction for Regionally Significant Habitat – Section B6).*

H. Average lot size and density transfer approaches may also necessitate greater flexibility in development standards such as maximum building coverage, lot dimensions, and setbacks. If use of lot size averaging or density transfer options require approval of a planned development, variance, or adjustment, developers will be less likely to use the methods.

I. The resource area associated with the density transfer shall be provided with long-term protection through dedication, an open space easement, deed restriction or other appropriate tool. This is already common in the Tualatin Basin for dedicated floodplain areas. Issues of access, maintenance, and management of the resource area must be considered as part of the density transfer.

J. If combined with other "green" design and development approaches, lot size averaging and density transfers could help to reduce effective impervious area in new development.

Recommendation for the Basin

1. Lot size averaging and density transfers are appropriate tools for the Tualatin Basin and are specifically recommended for sites that include or are adjacent to significant riparian and/or habitat areas. Local jurisdictions in the Basin should review their ordinances and document existing standards (e.g., amount of flexibility permitted), criteria (e.g., minimum development size), and procedures (e.g., Type III planned unit development) that apply to lot size averaging and density transfers.
2. Ordinance amendments may be needed to remove barriers (such as minimum site requirements to be eligible for lot size averaging) or to provide some consistency Basin-wide in how these methods will be used to protect Goal 5 resources.
3. Ordinances should allow lot size averaging and density transfer by right (subject to clear and objective standards) and should not require complex, discretionary review procedures such as planned unit development or variance approvals. A land division that involves lot size averaging or a density transfer should not be any more burdensome from a procedural standpoint than a standard land division.
4. In order to maximize flexibility, ordinances should specify the smallest buildable lot size that can be permitted within the zone as the minimum lot size that is permitted with lot size averaging or density transfer.
5. If the larger lot(s) in a land division based on lot size averaging are at least twice the minimum lot size, the local government may want to consider a deed restriction to preclude future division of the large lot(s).
6. The Basin jurisdictions may want to consider the provision of technical design assistance and outreach to property owners and potential developers of vacant or underdeveloped sites near significant riparian and/or habitat areas (similar to the Transportation & Growth Management "Quick Response" Program).

Examples and References

Most jurisdictions in the Basin have existing ordinance provisions that address lot size averaging and density transfers. These will need to be evaluated in order to ensure they provide adequate flexibility. For example:

The Washington County Code (Section 404-4) provides broad flexibility in lot sizes and development standards through the Type II planned development process to provide incentives for protection and dedication of open space. However, it appears only industrial and commercial planned development proposals are able to use floodplain, drainage hazard, or riparian open space on the subject property to offset up to 50% of the open space requirement. The Washington County Code (Section 300-3) also provides options for transfer of density from unbuildable lands within a single lot or parcel with the same land use designation or to an adjoining lot or parcel that is included in the development application and is within the same land use designation. For density transfer purposes, the definition of "unbuildable" lands includes designated significant natural resource areas, water quality sensitive areas or vegetated corridors. The transferred density shall not more than double the density allowed on the buildable portion of the site.

The Tigard Code (18.430.020D) permits "lot averaging," but no lot may be less than 80% of the minimum lot size permitted in the underlying zone. The Tigard Code (18.715.030) allows residential density transfer from sensitive lands, which includes the 100-year floodplain, natural drainage ways, wetland areas, and steep slopes. However, the number of units that can be transferred is limited to the number of units that would have been allowed on 25% of the unbuildable area. The total number of units per site shall not exceed 125% of the maximum number of units per gross acre permitted by the applicable plan designation.

2. Site Design

Key Questions	
Helps avoid or minimize impacts?	*Primarily minimize, potential to use flexibility to avoid impact to a habitat area.*
Applicable basin-wide or adjacent to resource area?	*Primarily adjacent to resource areas, but may also be used to protect other attributes (e.g. mature trees or habitat connectivity).*
New or amended regulations required?	*Some codes may have to be amended to provide additional flexibility.*
Tools to reduce effective impervious area (EIA)?	*No, unless combined with other "green" design and development approaches.*
Recommended for basin?	*Yes, only for properties which include resources.*

Description of Methods

Zoning ordinance development standards typically establish specific minimum lot size, lot dimensions, setbacks, building heights, and maximum lot coverage, particularly within residential zoning districts. The standards are applied at the land division, site plan, or building permit phases of development. When applied too rigidly, these types of standards can result in increased impacts on resource areas. Allowing flexibility can enable and encourage sensitive site designs and may be necessary to facilitate lot size averaging and/or on-site density transfer *(see discussion in Section B1)*. In addition to avoiding development immediately within or adjacent to resource areas, sensitive site designs could take into account the preservation of mature trees and connectivity between habitat areas. If a site is adjacent to or near habitat areas, wildlife and migratory birds may use the site as a pathway. Whenever possible, these pathways should be preserved or enhanced to provide continued access and protection for wildlife.

Examples include:

- Building setback flexibility to maximize the separation of the proposed development from the resource area (with the option to reduce setbacks to the minimum required by fire and building codes).
- Automatic flexibility in lot dimensional standards (such as 30% adjustment) to facilitate on-site density transfers and protection of the resource area.
- Building height flexibility (such as one-story bonus over base building heights) to facilitate avoidance and protection of the resource area.

- Bonus lot coverage if the proposed development is concentrated on smaller lots or in a smaller area of the overall site than permitted under base development standards.

Benefits and Challenges

A. Greater flexibility in development standards (particularly if it doesn't trigger a more complex review procedure) could encourage avoidance and protection of significant resource areas and enable the use of other tools such as on-site density transfer and lot size averaging.
B. Surrounding property owners or the larger community may be resistant to smaller lots, taller buildings, or reduced setbacks, particularly if they do not view the protection of the resource area as a corresponding benefit.
C. Most of the development in the urbanized portion of the Basin is now limited to relatively small-scale redevelopment and infill projects. In infill settings in particular, surrounding property owners may feel that the new projects are out of character with neighborhood design, and that reductions in setback standards and increased building height reduce privacy on adjoining parcels.
D. A developer will not pursue the more flexible development approach to protect the resource area if the alternative site plan is perceived as more difficult to permit, more difficult to finance, or less marketable.
E. Providing site design flexibility by right (subject to clear and objective standards) may help encourage preservation of the resource, but may be seen as conflicting with a jurisdiction's objectives for community involvement and citizen participation.

Recommendation for the Basin

1. Broader flexibility in development standards is recommended and should be targeted to sites that include or are adjacent to significant riparian and/or habitat areas. In addition, Basin jurisdictions should specify other attributes that may qualify for special flexibility (e.g. mature trees or habitat connections).
2. Local jurisdictions in the Basin should review their ordinances and document existing standards. Ordinances should specify the degree to which base development standards can be adjusted outright, with the option of a discretionary review if more flexibility is requested. It may be appropriate to consider a percentage modification in the development standards that is linked to the overall percentage of the site that is protected. For example, if the riparian/habitat area encompasses 20% of the overall site and is protected from development, all development standards applicable to the remainder of the site may be adjusted outright by up to 20%.
3. Similar to the recommendation for other topics, Basin jurisdictions may want to target technical design assistance and outreach to property owners and potential developers of vacant or undeveloped sites near significant riparian and/or habitat areas to encourage habitat friendly site plans.

Examples and References

The examples below illustrate how some of the Basin jurisdictions currently provide some flexibility from site design standards to facilitate natural resource protection.

The Washington County Code (404-2) allows only a limited modification of front, side, and rear yard setbacks (up to 10%) based on evidence that the modification is necessary to retain natural or topographic features such as mature trees, drainage swales, slopes, ridge lines, or rock outcropping. More extensive modification of standards (including lot sizes) requires approval of a Type II planned development.

The Tualatin Development Code (Chapter 72) includes options for shift of density for residential development adjacent to greenways and natural areas; landscaping credit for commercial and industrial planning districts adjacent to greenways and natural areas; and reduction in setback requirements adjacent to greenways and natural areas. Implementation of these options typically requires Architectural Review approval (Type II or III).

Beaverton's Code includes options for flexible setbacks (Chapter 40.30). However, flexible setback(s) for a proposed residential land division require a Type III approval.

3. Parking Design

Key Questions	
Helps avoid or minimize impacts?	*Use reductions in parking to avoid impact to a habitat area. Minimization also possible through EIA reduction.*
Applicable basin-wide or adjacent to resource area?	*Primarily adjacent to resource area, but could be used Basin-wide.*
New or amended regulations required?	*Yes – for some of the methods described.*
Tools to reduce effective impervious area (EIA)?	*Yes, these methods can provide EIA reduction.*
Recommended for basin?	*Yes, primarily for properties which include resources. Use of pervious pavement could have an EIA benefit, but use limited by soil constraints.*

Description of Methods

There are several methods related to parking lot design that could reduce the overall amount of impervious surface and cut down on stormwater runoff. The number of parking spaces created could be reduced through revisions to the parking requirements. Metro currently requires that all jurisdictions use parking maximums in their code to limit excessive parking. In addition, jurisdictions may allow alternative parking spaces to count towards the minimum parking standard. For example, adjacent on-street parking, nearby public parking and shared parking could all be included in the parking count. Metro recommends this, but does not require it.

Another technique is to minimize the size of the parking spaces created. Some jurisdictions have standards that allow a certain percentage of parking to be designed for compact vehicles. For example, the city of Tualatin allows no more than 35% of total parking stalls to be compact. Increasing this allowable percentage would be one way to reduce the overall size of a parking lot. Jurisdictions could also allow a higher percentage of compact parking (which would be a cost savings for the developer) in exchange for more beneficial landscaping. Parking stall design standards may also be revised in cases where the standard provides for a space that may be larger than necessary.

Large parking lots with catch basins generally require active stormwater control techniques, such as utilizing detention ponds and water quality treatment prior to discharge to a public system. As an alternative, the same amount of parking may be broken into several smaller parking lots that are

separated by natural vegetation (outside of required vegetated corridors) and bioretention areas *(see discussion of bioretention areas - Section C3).* This could reduce or eliminate the need for detention and/or piping and provide more opportunities for natural infiltration.[1]

Example of pervious parking material

There are a number of alternatives to conventional paving materials that can be used to reduce impervious surface area. Pervious concrete and asphalt both allow for more infiltration than traditional impervious pavement, and therefore have the effect of reducing the amount of runoff created by a parking lot. Pervious pavement may be most effective for driveways, sidewalks, and other pedestrian and bikeways that are not associated with public rights-of-way, which are subject to typical safety and maintenance practices in this area (sanding in winter conditions, street sweeping). Brick, pavers, and natural stone or gravel provide similar benefits, although the amount of infiltration is not as high. These materials are not always appropriate for high use parking lots, but they can be used in combination with conventional paving materials to provide at least some benefit.

Benefits and Challenges

A. In addition to possible water quality benefits, reducing the overall amount of required parking and/or the size of parking spaces reduces development costs, allows more space for landscaping, and provides greater efficiency of land use. However, in order to result in a reduction in EIA, the area that was no longer needed for parking should not be used for other impervious uses (e.g., larger buildings).

B. Allowing for smaller parking spaces or proportionately more compact spaces may result in a smaller overall parking area, but may not reflect the actual mix of vehicles that will be using the facility; and thus, could create some frustration on the part of users. In addition, adequate parking for trucks, large SUV's and RV's still needs to be provided.

C. Breaking up large parking lots and the use of natural vegetation creates a more attractive development while providing stormwater benefits.

[1] *Depending on local regulations, these methods related to parking lot design may not eliminate the need for required detention despite their effect on reducing stormwater runoff.*

D. Permeable paving materials may reduce development costs by reducing the need for stormwater infrastructure and treatment.[2] Bricks and pavers can also add visual appeal and character that may be desirable in commercial or residential areas.

E. There may be resistance to the idea of reducing parking requirements on the part of the community, particularly neighboring property owners. There may also be property owner concerns regarding shared parking arrangements.

F. Alternative paving materials may have higher installation costs to construct correctly and require more maintenance than regular asphalt and concrete. However, these costs could be offset to some degree by the savings associated with less stormwater treatment. This approach needs evaluation and monitoring to develop true costs. Overall development costs should always be considered when making a comparison between paving materials. Additionally, soil permeability issues in the Basin will also pose a challenge on some sites, as will slope stability and impacts to adjacent properties. Long term benefits are not well documented and required evaluation for long term effectiveness and maintenance costs.

Recommendation for the Basin

1. Basin jurisdictions should review and document their current parking standards in terms of minimum spaces, shared parking, parking space and parking aisle size, and percent of compact spaces permitted. Jurisdictions may want to revise their parking codes to require fewer and/or smaller parking spaces wherever possible and appropriate. For example, the City of Portland amended its zoning/development code to include these key elements:
    - Promote management of parking lot runoff within parking lot landscaping.
    - Reduce parking space dimensions to 16 feet x 18½ feet for 90-degree parking.
    - Reduce aisle width to 20 feet.
    - Specific requirements for parking lot runoff management are included in the city's *Storm Water Management Manual.*
2. Shared parking should be recommended and encouraged for all new developments where the uses may be able to utilize this type of arrangement. Basin jurisdictions should also consider allowing alternative parking arrangements (on-street, etc.) to count towards the overall parking standard and explore ways to mitigate potential conflicts this could generate within neighborhoods.
3. Encourage construction of structured parking and shared structured parking.
4. The long term effectiveness and maintenance costs of alternative paving methods need to be fully assessed. Alternative paving methods (pavers and/or permeable pavement) should be

[2] According to Washington County Engineering Standards, the piping requirements for larger and longer duration storm events may still be required.

permitted where appropriate on an individual basis. For private development, basin jurisdictions may want to provide information about these alternatives to permit applicants. This should be coordinated with CWS specifications.

5. Basin jurisdictions could offer potential developers some examples of parking lot design alternatives that incorporate some or all of these techniques. They might consider creating a "toolkit" that could be handed out to developers to provide information about LID methods and their benefits, case studies, and additional resources available to them.

Examples and References

CWS Merlo Road Field Operations Facility

The Field Operations Facility's employee parking lot is paved with porous concrete. Porous concrete allows rainfall to be absorbed directly into the soils below, recharging groundwater and reducing or eliminating any surface runoff. The porous parking lot acts as a retention facility, slowing the flow and replicating natural hydrology. The cost of porous concrete is offset in part by the elimination of catch basins and pipe conveyance systems.

Concrete paver blocks provide seven additional parking places (945 square feet) for visitors to the Field Operations Facility. Spaces between the interlocking pavers allow stormwater to be absorbed into the sub-base and soils below. Porous pavers are commonly used and readily available, and can be more attractive than asphalt or conventional pavement.

Structural gravels supported by an 8-inch deep synthetic grid provide 3,000 square feet of storage area in the Field Operations Facility maintenance yard. The three-dimensional network of interconnected, perforated cells was filled with 11/2-inch to 3/4-inch open graded river gravel.

[Source: Clean Water Services, "Slow the Flow! Designing the Built Environment to Protect Urban Environments" brochure
http://www.cleanwaterservices.org/content/documents/Permit/Slow%20the%20Flow%20brochure.pdf]

4. Landscape/Hardscape Design

Key Questions	
Helps avoid or minimize impacts?	*Both avoid and minimize.*
Applicable basin-wide or adjacent to resource area?	*Primarily adjacent to resource area, but could be used Basin-wide.*
New or amended regulations required?	*Yes – for some of the methods described.*
Tools to reduce effective impervious area (EIA)?	*Yes, subject to local soil conditions.*
Recommended for basin?	*Yes, primarily for properties which include resources. Tree preservation, additional landscaping and soil amendments would have an EIA benefit.*

Description of Methods

Methods can include enabling and encouraging the use of rain gardens, native landscaping, and tree canopy preservation. More information about rain gardens is provided in Section C3 of this paper. Native landscaping, also called "lawn conservation," focuses on planting or replanting lawns or sections of lawns to a more natural state. This includes planting hardy native plant species of grasses, shrubs, wildflowers and/or trees, which require less maintenance than the conventional lawn. One benefit of native landscaping to the local watershed is that it requires little or no fertilizer or pesticides. Lawn conversion also provides stormwater management that promotes groundwater infiltration, water quality treatment, and flood control. Some general conservation landscaping techniques are listed here.

- Minimize the use of supplemental watering by using appropriate plants, mulching, drip irrigation, and captured rainwater.
- Minimize the amount of lawn in order to reduce fertilizer and pesticide use, cut down on watering, and create habitat for wildlife.
- Plant to create windscreens and buffers and reduce erosion.
- Reduce the use of pesticides and fertilizers through the use of native plants, lawn conversion, natural soil enhancers, and soil aeration.
- Minimize bare soil and stabilize slopes with planted ground cover.
- Capture and detain water for use in landscaping.
- For hardscaped surfaces, use permeable paving like bricks or pavers instead of concrete and asphalt.
- Preserve existing trees and plant additional trees where appropriate.

Trees and the canopy they provide are an important component of landscaping for water quality. An intact tree canopy can reduce the amount of precipitation that results in runoff, thus reducing the amount of stormwater that needs to be treated. There are also habitat benefits to preserving resource areas with tree canopy and vegetative cover. Tree roots stabilize soil and reduce erosion, and the shade that trees provide acts as a shelter and cooling agent. Trees also purify the air, provide habitat for birds and wildlife, and add character and aesthetics to an area. Some development ordinances require preservation of trees during construction to the extent possible, and mitigation if a tree must be removed. Others impose a penalty if a tree is cut down on a property without a permit – the fine can vary depending on the type, size, and age of the tree.

Benefits and Challenges

A. Conservation landscaping is a low-cost way to minimize stormwater runoff. Savings are created through reduced maintenance, water use, and treatment.
B. Many people prefer the more natural look and feel of native landscaping. However, it may also be perceived as "weedy" and "unattractive." Informative signage near these areas may help to educate the public and prevent negative impressions.
C. If jurisdictions do not allow vegetated stormwater management facilities to count towards the overall landscaping requirement, it can act as a disincentive to developers. While it may provide some incentive for their creation, allowing these facilities to count toward landscaping requirements will not result in an increase in pervious surface.
D. Many of these methods also provide air quality benefits, help to reduce temperatures during summer months, and create suitable habitat for wildlife, especially birds and butterflies.
E. There is the potential to use development activities on a site as an opportunity to encourage improvement of existing resource areas.
F. Some jurisdictions currently allow hardscape areas to be counted toward the required landscaping percentage. While this may improve opportunities for pedestrian connectivity within a development site, it may reduce the overall perviousness.

Recommendations for the Basin

1. Basin jurisdictions should review and document[3] their current landscape standards. Basin jurisdictions should consider revising their existing landscaping requirements to incorporate some of the methods mentioned above. Potential revisions may include:

[3] Local jurisdictions should document their current standards to determine to what extent they are already employing the explored methods/approaches, achieving the same results as expected through the use of alternative methods/approaches, and/or could modify existing standards to employ the explored methods/approaches. It is also a way to documents the "good work" jurisdictions are already doing.

- Allow vegetated stormwater facilities *(also see discussion of rain gardens[4] and bioretention in Section C3)* to count towards the minimum landscaping requirement. This will act as an incentive to developers.
- Provide incentives or credit for the preservation of existing native vegetation (trees, shrubs, and ground cover, for example).
- Revise the code so that the purpose section of the landscaping requirement includes language about reducing stormwater runoff and providing for infiltration.
- Allow only pervious hardscape to be counted towards the required landscaping.

2. Additional education and incentive programs for developers are recommended. Demonstration projects are a useful educational tool and show government support for the methods. Long term evaluation of current commercial landscape maintenance practices should be included in review.
3. The Basin should evaluate opportunities to use fees (SWM, local surcharges or independent environmental impact fees) and fee waivers as incentives/disincentives that will encourage developers to seek alternatives.
4. Encourage the preservation and enhancement of on-site resource areas. Maintaining resource area connectivity for wildlife habitat should be stressed.
5. Visit, evaluate, and document the success of public investment in regional watershed stewardship grants (see example below). Explore elements that can be borrowed or changed to be applicable for Basin jurisdictions.

Examples and References

Community Watershed Stewardship Program

Watershed stewardship grants provide up to $5,000 to citizens and organizations to encourage watershed protection and enhancement at the local level. Grant money can be used for supplies, materials, equipment, room rentals, feasibility studies or technical assistance. The Grant Program is a partnership between the City of Portland Environmental Services, Portland State University, and the Northwest Service Academy. The program provides financial and technical support to foster partnerships that improve the health of local watersheds. From 1995 through 2004, the program dispersed $360,000 to 92 projects across the city. These funds were matched by over $1 million in community support through donations of services, materials and volunteer time. As of Fall 2002, of the 62 projects that included physical improvements to the landscape, 54 (87%) are still active and supported by the community. Over 17,000 people have donated 93,219 volunteer hours, which includes planting over 56,215 native trees and shrubs.
[Source: City of Portland Bureau of Environmental Services]

[4] *Note that 'rain gardens' do not qualify as "stormwater facilities" in the Tualatin Basin.*

References:

[NOTE: While these references provide good examples of ways to employ conservation landscaping, implementation in the Tualatin Basin may require modifications due to the specific climate and soil types in the region.]

- "Healthy Landscapes," University of Rhode Island http://www.uri.edu/ce/healthylandscapes/tips/5.html
- Landscaping for a Healthy Planet" Pennsylvania Audubon and Alliance for the Chesapeake Bay
- http://www.envirolandscaping.org/conservation.htm
- "Skills for Protecting Your Stream: Retrofitting Your Own Backyard," Center for Watershed Protection, April 2002 http://www.cwp.org/Community_Watersheds/educating_constituents.htm

5. Lighting Design

Key Questions	
Helps avoid or minimize impacts?	*Minimize*
Applicable basin-wide or adjacent to resource area?	*Applicable to areas adjacent to resource areas.*
New or amended regulations required?	*Adoption of ordinance language required for jurisdictions that currently do not have a lighting ordinance; possible amendments to existing lighting ordinances to include measures associated with mitigation for habitat areas.*
Tools to reduce effective impervious area (EIA)?	*No*
Recommended for basin?	*Yes, although information on lighting impacts on Basin specific species may not be available.*

Description of Methods

When outdoor lighting is not designed, installed, or managed properly, deleterious effects to natural systems can occur. Some of the biological and behavioral activities of plants, animals (including birds and amphibians), insects, and microorganisms are either adversely affected by light or can only function effectively in darkness. Such activities include foraging, breeding, and social behavior in higher animals, amphibians and insects, which are all affected in various ways when artificial light is introduced into their environment.

Artificial light at night can disrupt hunting, migrating, and reproductive patterns of invertebrates, mammals and birds. Lighting used along river corridors, near woodland edges and near hedgerows can be particularly harmful to animals that hunt and live in these habitats. There is also evidence that trees and plants can be impacted by lighting because of their sensitivity to day length and seasonality. Prolonged artificial light can alter their flowering and dormancy cycles.

Different light sources have different emission spectra; different types of lamps give off more or less light of certain wavelengths (color).

Benefits and Challenges

A. Many of the jurisdictions in the Basin already have current lighting regulations that mitigate the affects of artificial lighting in their development codes. Typically these regulations include allowed or prohibited lamp types, screening requirements, and required elements of a lighting

plan that mitigate the affects of artificial lighting on neighboring developments and existing housing. Measures that shield humans from unwanted light can also benefit habitat areas.

B. Proposed lighting plans associated with new development can be reviewed and regulated with the development plan approval process. Measures that are related to habitat, and not typically required in local jurisdictions' ordinances, such as ensuring that the species of tree proposed is suitable with the lighting plan, shielding artificial lighting from habitat areas as well as existing development, or consultation with a habitat biologist regarding the presence and needs of animal species in the area, could be included in development regulations.
C. There may be less opportunity for retrofitting lighting plans and fixtures in existing development where lighting may be detrimentally impacting riparian and habitat areas. Existing lighting designs with the most impact will likely be associated with large developments, such as commercial centers and industrial campuses, and the best opportunity to require changes to the lighting type or plan is when the property expands or redevelops.
D. There is not a lot of available research that quantifies the long-term effects of artificial light on habitat areas. While species-specific information regarding the disruption of natural patterns due to artificial light is more abundant, not all of these species are prevalent in the Tualatin Basin. The lack of quantifiable evidence of the effects of artificial light or night lighting on habitat areas, and the existence of arguably more pressing issues, such as reduction of habitat areas due to development, may downplay the importance of this issue. The benefits of mitigating artificial light are also difficult to measure.

Recommendation for the Basin

1. Basin jurisdictions should review and document their current lighting standards.
2. Basin jurisdictions could consider revising their existing lighting requirements to incorporate some of the following concepts:
    - When artificial lighting is installed, mercury vapor, metal halide, or fluorescent lamps should be used in this order of preference. High-pressure sodium lamps should be avoided; low-intensity incandescent lighting is also not recommended. Evaluate power and maintenance costs and coordinate with power provider/ lighting utility and local road jurisdiction.
    - Shielding fixtures so that all light is directed toward the ground onto pedestrians and vehicular traffic and away from plants is one way to reduce light pollution for trees. Up-lighting and shining light over great horizontal distances should be avoided.
    - Lights should be turned off or dimmed during off-peak hours to avoid continuous lighting of trees, which has the greatest potential for upsetting normal growth patterns.
    - When planting trees where supplemental night lighting already exists, choosing those with low sensitivity to light is recommended. There is a good deal of variation in the

susceptibility of woody plants to artificial lighting. Highly sensitive trees should be avoided in areas where high intensity lighting rich in red and infrared wavelengths is used.

- The type of lighting used in and near habitat areas is also a consideration. Low pressure sodium lamps have less impact on fauna than high pressure sodium or mercury lamps. Keeping the brightness of lights as low as legally possible and planning lighting schedules that allow some dark periods can also mitigate the affects of lighting on animals. Where possible, lighting should be directed to where it is needed to avoid light spillage; limiting the height of lighting columns and directing light at a low level reduces the ecological impact of the light. Also, knowledge of sensitive species in the area and their biological needs can be used to design lighting and installation plans that minimize their impact.

Examples and References:

[NOTE to TBSC: This section is still in work – It would be ideal to have descriptions and pictures of local examples, please suggest any local examples you might have available.]

- LightLinx List Index, Light Pollution Awareness Links. http://members.aol.com/ctcadman/LiteLynx.htm
- Alessi, Ryan. "Protecting Animals from 24-7 Light", Scripps Howard News Service, January 09, 2002 http://www.knoxstudio.com/shns/story.cfm?pk=DARKSKY-SPECIES-01-09-02&cat=AN
- Fatal Flight Awareness Program (FLAP). http://www.flap.org/new/nocturnfr.htm
- "Impact of Lighting on Bats", based on a document produced by Dr. Jenny Jones (May 2000) http://www.0ad.co.uk/bats/downloads/Helpline/lighting.pdf
- Chaney, William R. "Does Night Lighting Harm Trees?", Purdue University Department of Forestry and Natural Resources, Purdue University, West Lafayette, IN 47907
- http://www.ces.purdue.edu/extmedia/FNR/FNR-FAQ-17.pdf
- "Ecological Consequences of Artificial Night Lighting" Conference Abstracts, The Urban Wildlands Group, http://www.urbanwildlands.org/abstracts.html
- "Ecology of the Night", Muskoka Heritage Foundation (Canada) http://www.muskokaheritage.org/ecology-night/scotobiology.asp
- Bidwell, Tony. 'Scotobiology of Plants", Conference material for the Dark Sky Symposium held in Muskoka, Canada, September 22 -24, 2003 http://www.muskokaheritage.org/ecology-night/media/tony-bidwell.pdf

6. Density Reduction

Key Questions	
Helps avoid or minimize impacts?	*Avoid and minimize*
Applicable basin-wide or adjacent to resource area?	*Adjacent to resource areas*
New or amended regulations required?	*Codes may need to be amended to allow waivers from minimum density requirements.*
Tools to reduce effective impervious area (EIA)?	*Yes*
Recommended for basin?	*Yes, only for properties which include resources.*

Description of Methods

Objectives to preserve regionally significant riparian and habitat areas within the urban area may conflict with objectives to achieve minimum densities and avoid expansion of the Urban Growth Boundary (UGB). Minimum density requirements, along with other factors such as escalating land prices and development costs, have had an impact on shrinking residential lot sizes. Minimum density requirements may have also resulted in pressures and impacts on significant riparian and habitat areas inside the UGB. The impact of this issue may increase as many of the remaining developable areas within the UGB have constraints, and it can be a challenge to fit the required number of dwellings on these sites in a manner that is habitat friendly.

Metro's Functional Plan (Section 3.07.140) states that "a city or county shall not approve a subdivision or development application that will result in a density below the minimum density for the zoning district." The potential impact of this requirement is off-set by the fact that the Functional Plan (Section 3.07.1010) definition of a "net acre" excludes "... environmentally constrained areas, including any ... natural resource areas protected under statewide planning Goal 5 in the comprehensive plans of cities and counties in the region.... These excluded areas do not include lands for which the local zoning code provides a density bonus or other mechanism which allows the transfer of the allowable density or use to another area or to development elsewhere on the same site..." Similarly, most local ordinances already allow developers to subtract sensitive areas such as floodplains, Title 3 buffers, and steep slopes from gross acres before calculating required minimum densities.

While many local ordinances offer density bonuses to encourage protection of significant resource areas and to avoid regulatory takings, a waiver from minimum density requirements may be just as

attractive to the development community and could facilitate greater protection of resource areas. Minimum density requirements are most commonly an issue for residential development. However, minimum floor area requirements also apply to non-residential development in regional centers, town centers, and station areas. Expectations for minimum floor area ratios and more intensive mixed use development in these areas may be difficult to balance with resource protection and reductions in effective impervious area.

Local ordinances could be further amended to reduce or eliminate minimum residential density and floor area requirements for specific areas or types of resources (such as regionally significant habitat, and Goal 5 resources designated on local comprehensive plans). Potential *maximum* densities or floor area ratios would not be affected.

Benefits and Challenges

A. Developers (and neighbors) may view waivers to minimum density requirements as a positive tool to avoid and protect significant resource areas.
B. Combined with protection of the resource area, fewer residential lots or less commercial floor area could also result in reductions in effective impervious area.
C. Minimum density requirements are an important regional tool to manage the UGB. Metro may be reluctant to allow waivers, or may want to tie them very tightly to protection of regionally significant habitat.
D. Many individuals, neighborhood groups, or local governments in the region have concerns with or are opposed to minimum density requirements for other reasons (traffic and school congestion, urban design, etc.). If waivers to minimum density requirements are granted for protection of resource areas, there may be pressure to expand the waivers for other situations.
E. Local governments may be hesitant to encourage the implementation of this approach because of the economic impacts resulting from a decrease in overall development capacity. This issue could be addressed by reallocating the "lost" density back to the jurisdiction or subregion.

Recommendation for the Basin

1. Granting waivers to minimum density requirements is an appropriate tool to consider, if tied to long-term protection of the resource area, such as dedication, or an open space easement.
2. Tualatin Basin Partners, in coordination with Metro, will need to evaluate the number and location of resource areas that may be eligible for density waivers and identify a means of ensuring that lost density is reallocated back to the jurisdiction or Basin.
3. Local governments should coordinate with the development community to test the idea of waivers to minimum density requirements in concert with protection of the resource area. Politically, the concept may not be worth pursuing if the applicability is minimal or the developer interest is low.

Examples and References

All of the jurisdictions in the Basin have adopted ordinance requirements for minimum densities to comply with Title 1 of the Metro Functional Plan. Most jurisdictions have also adopted provisions that allow (1) subtracting Title 3 and Goal 5 natural resource areas from gross acreage before calculating minimum density requirements; and (2) transfering density from constrained or unbuildable areas to buildable portions of the site.

See the Tigard Code (18.715.020), and the Washington County Code (300-2) for examples of approaches to calculate net density and minimum density requirements.

C. ENGINEERING AND DESIGN APPROACHES

The engineering and design approaches described in this section typically require a more innovative approach to engineering and may require the adoption of new design specifications and public works standards. Amendments to transportation system plans may also be needed. These measures, in particular, will require close cooperation with Clean Water Services stormwater management program and updates of their Design & Construction Standards. Engineering and Design approaches described in this section consider innovative practices that are commonly used, as well as those that may not be as widely known to the public, as possible approaches.

Many jurisdictions throughout the Tualatin Basin currently employ practices that minimize the impacts of street construction and address water quality standards while minimizing maintenance costs. It is common for major road improvement projects to employ a variety of public involvement techniques, including citizen project advisory committees, open houses with the public, and mailers to homeowners in the area to solicit comments on the project design. This input can have a direct impact on landscape and sidewalk design, road alignments, and lighting details. Also, it is common practice for jurisdictions to coordinate road design closely with emergency responders to ensure safety is not compromised.

The clay soils of the Basin have limited the use of some methods. Implementing the engineering and design methods described in this section may require specific monitoring and evaluation on a prototype basis, as well as coordination with Clean Water Services and other local jurisdictions, to determine the short and long-term benefits of using specific approaches within the Basin. The engineering and design approaches considered in this section include the following:

1. Street design
    - Methods include minimizing paving (reducing street width, length, cul-de-sac radii, using vegetated islands in center), using pervious paving materials, maximizing street tree coverage, using multi-functional open drainage systems in lieu of more conventional curb-and-gutter systems, modifying drainage practices (e.g., allowing sidewalks to drain into yards or adjoining landscape areas rather than to the street system)

2. Stream crossing and street connectivity standards
    - Methods include minimizing the number of stream crossings and placing crossings perpendicular to the stream channel, allowing narrow street right-of-ways through stream corridors, using habitat sensitive bridge and culvert designs

3. Stormwater management facility design
    - Methods include using vegetated stormwater management facilities, such as bioretention cells or rain gardens[5]; detention ponds, underground detention and detention criteria specific to the local stream needs; water quality swales

[5] NOTE: these do not qualify as stormwater treatment facilities under CWS' standards.

1. Street Design

Key Questions	
Helps avoid or minimize impacts?	*These methods can be used to minimize and avoid impacts.*
Applicable basin-wide or adjacent to resource area?	*Effective Basin-wide.*
New or amended regulations required?	*May require transportation system plan and code amendments and amendment to public works/engineering standards. Could be an option for developers, and encouraged for prototype public improvement projects.*
Tool to reduce effective impervious area (EIA)?	*Yes*
Recommended for basin?	*Yes; however, use of some methods will be limited by site suitability.*

Description of Methods:

The Practice of Low Impact Development (published by the Partnership for Advancing Technology in Housing in July 2003) notes that besides rooftops and driveways, residential streets account for an enormous share of a community's impervious surfaces. Street designs that minimize the amount of paved area by reducing street width, cul-de-sac radii or length, can result in an overall reduction of effective impervious area provided the area saved is not made impervious by development. Narrower roads encourage travel at posted speeds as well as reduce overall impervious area. In addition, the *Regional Transportation Plan (RTP)* Section 6.4.5 already requires that street design code language and guidelines allow for consideration of narrow street design alternatives (for local streets, no more than 46 feet of total right-of-way, including pavement widths of no more than 28 feet, curb-face to curb-face, sidewalk widths of at least 5 feet and landscaped pedestrian buffer strips that include street trees).[6] However, because reduced street widths can create issues for emergency

[6] *The city of Beaverton currently allows a minimum 22 foot local street design and has noted a variety of issues and problems resulting from streets built to this standard. One key example cited by the city is that garbage haulers cannot use automated pick-up equipment in the narrow right-of-way. Washington County has a 24 foot minimum local street design standard and has also experienced a variety of problems. The Fire Marshall has recommended that these minimums be increased. [Source: Washington County Transportation Engineering]*

vehicle access, especially where on-street parking is allowed, implementation of narrow street standards will require additional review and concurrence by the Fire Marshall.[7]

Limiting street length is more difficult to address than street width as streets lengths are typically a matter of connectivity. However, for residential subdivisions, jurisdictions may be causing streets to be unnecessarily long by establishing large minimum frontage requirements. Further, the size of intersections could be reduced by allowing tighter turning radii. Reductions in the size of cul-de-sac radii are often precluded by the need to maneuver emergency and maintenance vehicles; however, jurisdictions could encourage the use vegetated islands in the center of cul-de-sacs or intersections.

According to an *APA PAS Memo* on low impact development, the Puget Sound Action Team, a government partnership charged with developing conservation programs to protect Washington State's Puget Sound, recommends several ways to reduce the length and amount of roadways:

- Lengthen street blocks to reduce the number of cross streets for grid or modified grid layouts.
- Provide pedestrian paths to connect the end of a cul-de-sac with other pathways, roads, or open spaces.
- Create pedestrian routes to neighborhood destinations that are direct, safe, and aesthetically pleasing.
- Narrow lot frontages and cluster homes to reduce the need for more roads.

These concepts are already being used in Washington County and other local Tualatin Basin jurisdictions to reduce the length and amount of roadways.

Pervious pavement allows stormwater to pass through it. While not recommended for high traffic areas, pervious paving materials could be used in low traffic areas within the public right-of-way, such as parking strips, shoulders, and sidewalks. However, local soil conditions and federal underground injection control (UIC) regulations may limit where pervious pavement may be successfully used in the Tualatin Basin. The stormwater impact of the street system could potentially be further mitigated by maximizing the use of street trees. Street trees may be able to help with runoff reduction and detention, conveyance attenuation, and water quality improvement. The use of multi-functional open drainage systems (e.g., swales or linear basins), as well as the modification of drainage standards for the movement of surface water (e.g., allow sidewalks to drain into yards or adjoining landscape areas rather than to the street system), can be used in lieu of, or in addition to, more conventional curb-and-gutter systems.

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[7] Washington County Transportation Engineering notes that the existing standards have been closely coordinated with the State and local Fire Marshall and represent the minimum widths currently allowed.

Benefits and Challenges:

A. Narrower street widths will only result in a decrease in EIA if the extra width is used to provide landscaping or other pervious area. The *Stormwater/Pavement Impacts Reduction (SPIR) Project Report* recommends that street cross-sections be amended to conform to Metro's *Green Streets* and *Creating Livable Streets* design guidelines. To the extent that these cross-sections may be narrower than those within adopted transportation system plans, amending the cross-sections (especially where on-street parking is allowed) will require further discussions with public service providers to resolve accessibility issues for larger vehicles (fire trucks, street sweepers, garbage & recycling trucks, etc.).

B. Longer blocks may result in an increase in out-of-direction travel and congestion (see discussion of street connectivity in the next section).

C. Locating linear swales within the planting area between the sidewalk and the travel may have significant maintenance costs and affect pollutant load (e.g., increased pollutant loading from pet waste). CWS, as the stormwater management authority in the Basin, sets maintenance roles and responsibilities. However, adjacent property owners are traditionally responsible for maintaining the planting areas between the sidewalk and travel lane. Managing stormwater in the planting area creates a utility function within the planting area and may lead to conflicts with regard to maintenance responsibility and the increased costs. Ensuring long term stormwater function and maintenance has been a major challenge on private properties and it may not be feasible to transfer public runoff responsibility to private frontage owners.

D. Structural design solutions such as infiltration trenches and basins and vegetated swales require regular inspection and maintenance. Because most public works departments are set up to maintain existing traditional systems, they may not currently have the staff or equipment required for this maintenance.[8] While these methods may result in a net cost-savings within the Basin, public works departments may experience a cost increase, at least in the short-term. For example, Metro's 2001 cost comparison for a regional boulevard estimated landscape/maintenance as follows: $6,950 for a standard street (based on Washington County standards) vs. $264,583 for a Metro Green Street Boulevard.

E. The use of methods that rely on the infiltration of stormwater will be limited to those areas of the Tualatin Basin with suitable soils and ground water levels.[9]

These standards are reviewed periodically with the Fire Marshall and may be revised in light of experience and practice.

[8] Washington County Transportation Engineering staff notes that open drainage systems have been monitored and found to greatly increase stormwater maintenance costs for trash patrol. There are also issues regarding potential increases in fecal coliform pollution due to pet waste.

[9] A review of the SCS (NRCS) Soil Survey of Washington County - Table 8 - show all soils except three to be listed with "restrictive soil features" which preclude infiltration including one or more of the following: "wetness, too clayey, or severe slopes." One soil that is not so restricted is the "Briedwell" series soil located in T.2S., R.1W., section 13 - in Tualatin/ Durham area. The other two, Hillsboro and Willamette

F. Potentially underground injection control (UIC) rules may restrict the infiltration of road runoff in areas which utilize underground storage of drinking water.

Recommendation for the Basin:

1. Where jurisdictions have already adopted standards to allow for narrow street widths in compliance with the RTP, this information should be documented in the final report. In order to decrease EIA, cross-sections for narrower streets should reflect a corresponding increase in pervious area.
2. Jurisdictions within the Basin could consider adding consistent policy language to their comprehensive plans, transportation system plans, and public works standards allowing the use of alternative street design cross sections. Approval for use of alternative street designs should be based on non-discretionary criteria.
3. In order to encourage the implementation of these specifications, jurisdictions should identify clear and objective (non-discretionary) performance criteria for use of alternative designs and establish an approval process for alternative designs that will not require a variance.
4. Additional information from the Green Streets Technical Advisory Committee final report should be considered when available.
5. Identify mechanisms to ensure increase maintenance costs are adequately funded.
6. Utilize existing detention and water quality methods and optimize release criteria for the local conditions. Maximize storage criteria in the upper basins as feasible.
7. Consider removing street stubs that cannot be extended and utilizing right-of-way for open space and native vegetation.

Examples/References:

CWS Merlo Road Field Operations Facility

The access road to the Field Operations Facility is a "green" street with no curb and gutter on the south side of the street. Vegetated swales planted with native trees and shrubs replace traditional catch basins and conveyance pipes. Stormwater is absorbed into the soil and plant roots instead of being concentrated and directed to a storm drain, stream or wetland. Green streets treat stormwater within the right of way, while providing maximum tree canopy to intercept rainfall and to cool road surfaces. There were no extra costs for this access road, compared to a standard street development. Swales replaced traditional catch basins and underground pipes, which reduced costs and minimized potential sediment impacts during construction. However, one study of construction costs found a "green" boulevard was 22 percent more costly than a conventional boulevard. The 2002 study was conducted by Metro

soils, are listed as low strength and would require site specific testing and long term evaluation. [Source: Washington County Transportation Engineering]

regional government, comparing costs in Washington County, Oregon. Still, stormwater credits may be available to offset extra costs.

[Source: Clean Water Services, "Slow the Flow! Designing the Built Environment to Protect Urban Environments" brochure]

Street Edge Alternatives (SEA) projects

Seattle's public utilities and transportation departments are experimenting with LID design elements in their Street Edge Alternatives (SEA) projects. By modifying circulation design, SEA Streets significantly improved stormwater management: the initial project to retrofit a 660-foot long residential street has resulted in a 98 percent reduction in stormwater runoff over the past three years. The project was initiated to control heavily polluted stormwater that ran off impervious road surfaces, adversely affecting the area's creeks and wildlife. To minimize these impacts, more than 100 evergreen trees and 1,100 shrubs were planted, the road width was reduced from more than 20 feet (plus space for angled parking) to 14 feet, and grassed swales and two feet of grass shoulder were added next to the curb-free roads. The amount of parking was determined by each owner, and parallel and angle parking was grouped between swales and driveways. Sidewalks were installed on only one side of the road, which was considered adequate for residential communities.

[Source: APA PAS MEMO, Low Impact Development: An Alternative Approach to Site Design]

References:

- Clean Water Services, "Slow the Flow! Designing the Built Environment to Protect Urban Environments" brochure http://www.cleanwaterservices.org/content/documents/Permit/Slow%20the%20Flow%20brochure.pdf
- Creating Livable Streets: Street Design Guidelines for 2040, 2nd edition. Metro, June 2002.
- Green Streets: Innovative Solutions for Stormwater and Stream Crossings, 1st edition. Metro, June 2002.
- Low Impact Development: An Alternative Approach to Site Design. APA PAS MEMO, Asa Foss, May/June 2005
- The Practice of Low Impact Development. US Department of Housing and Urban Development, Office of Policy Development and Research, Contract No. H-21314CA, July 2003.
- Review of Low Impact Development Techniques. CH2MHILL on behalf of the Puget Sound Action Team., January 2004.
- Stormwater/Pavement Impacts Reduction (SPIR) Project Report, Audubon Society of Portland, 2004.

2. Stream Crossing and Street Connectivity Standards

Key Questions	
Helps avoid or minimize impacts?	*Primarily used to avoid impacts.*
Applicable basin-wide or adjacent to resource area?	*Primarily adjacent to resources.*
New or amended regulations required?	*Amendments may be required, but will not increase requirements for private development.*
Tool to reduce effective impervious area (EIA)?	*No*
Recommended for basin?	*Yes*

Description of Method:

Stream crossings can have a significant impact on in-stream water flow as well impacts on the adjacent riparian area They can also impede the travel patterns of fish and wildlife. Typically, bridges have fewer in-stream impacts than culverts. CWS's *Healthy Stream Plan* found that "in the urban portion of the Tualatin Basin most bridges "... are adequately sized to convey significant flood flows, and allow for fish passage. Conversely, culverts ... are often undersized for significant flood flows, frequently alter the geomorphic condition of the stream, and limit fish passage." Stream crossing can also affect other wildlife by interrupting a pathway. When the crossing interrupts a terrestrial pathway, properly located fencing and natural landscaping can help guide animals around or through these areas.

Improving stream crossing within the Basin has been an on-going effort. Basin jurisdictions have constructed stream crossings to fish- and wildlife-friendly standards for more than 20 years. With State and Federal resource agencies as participants, each project is reviewed, designed and constructed with fish and wildlife benefits as a project feature. While many older culverts do impede fish and wildlife, these are being identified and corrected in a coordinated and systematic manner by the jurisdictions under the Healthy Streams Plan. In addition, culvert construction within the upper portions of the watershed allows for detention facilities that can offset the impacts of existing and proposed development and that help to restore stream geomorphology to a pre-development condition.

Street connectivity standards can also impact riparian and habitat areas. According to an *APA PAS Memo* on low impact development, depending on the density, location, and type of development, a hybrid street network that combines a conventional grid with a curvilinear system can reduce the amount of total roadways while still allowing for smooth traffic circulation. Most jurisdictions in the

Basin have adopted street connectivity standards that emphasize transportation functionality, but which also recognize barriers to connectivity, such as natural resource areas.

The *Regional Transportation Plan (RTP)* establishes the following standards for street connectivity within the region. As highlighted in bold below (emphasis added), the RTP design standards include some exceptions for stream crossings; however, exceptions for other habitat impacts are not provided (e.g., avoidance of upland habitat areas).

> *Section 6.4.5 Design Standards for Street Connectivity*
>
> *2. In addition to preparing the above conceptual street plan map, cities and counties shall require new residential or mixed-use development involving construction of new street(s) to provide a site plan that reflects the following:*
>
> *a. Street connections:*
>
> - *Responds to and expands on the conceptual street plan map as described in Section 6.4.5(1) for areas where a map has been completed.*
> - *Provides full street connections with spacing of no more than 530 feet between connections except where prevented by barriers such as topography, railroads, freeways, pre-existing development, or where lease provisions, easements, covenants or other restrictions existing prior to May 1, 1995, which preclude street connections.*
> - *Where streets must* ***cross water features i****dentified in Title 3 of the Urban Growth Management Functional Plan (UGMFP), provide crossings at an average spacing of 800 to 1,200 feet,* ***unless habitat quality*** *or length of crossing prevents a full street connection.*
>
> *b. Accessways:*
>
> - *When full street connections are not possible provides bike and pedestrian accessways on public easements or rights-of-way in lieu of streets. Spacing of accessways between full street connections shall be no more than 330 feet except where prevented by barriers such as topography, railroads, freeways, pre-existing development, or where lease provisions, easements, covenants or other restrictions existing prior to May 1, 1995 which preclude accessway connections.*
> - *Bike and pedestrian accessways that* ***cross water features*** *identified in Title 3 of the UGMFP should have an average spacing no more than 530 feet,* ***unless habitat quality*** *or length of crossing prevents a connection.*
>
> *c. Centers, main streets and station communities: Where full street connections* ***over water features*** *identified in Title 3 of the UGMFP cannot be constructed in centers, main streets and station communities (including direct connections from adjacent neighborhoods), or spacing of full street crossings exceeds 1,200 feet, provide bicycle and pedestrian crossings at an average spacing of 530 feet,* ***unless exceptional habitat quality*** *or length of crossing prevents a connection.*
>
> *d. Other considerations:*
>
> - *Limits the use of cul-de-sac designs and other closed-end street systems to situations where barriers prevent full street extensions.*
> - *Includes no closed-end street longer than 200 feet or with more than 25 dwelling units.*
> - *Includes street cross-sections demonstrating dimensions of right-of-way improvements, with streets designed for posted or expected speed limits.*

- *For replacement or new construction of local street crossings on streams identified in Title 3 of the Urban Growth Management Functional Plan, Cities and Counties, TriMet, ODOT and the Port of Portland shall amend design codes, standards and plans to* ***allow consideration of the stream crossing design guidelines contained in the Green Streets handbook***.

As noted above, the RTP includes a cross reference to the stream crossing design guidelines in the *Green Streets* handbook. Fewer street connections could reduce the overall amount of EIA within the Basin; however, by shifting traffic to fewer through streets, more travel lanes could be needed on the through-streets and therefore could be a potential increase in out-of-direction travel.

Benefits and Challenges:

A. Additional analysis of existing stream crossing may be needed. The analysis conducted for the Healthy Stream Plan, which was limited in terms of time, budget and jurisdiction, represents only a portion of the total number of structures.
B. Improvements to existing culverts are expensive. Based on a study of 1,200 culverts and bridges, the Healthy Stream Plan has identified 383 culverts in the Basin as priorities for improvement.[10]
C. Providing a high level of street connectivity has a number of transportation benefits, but these benefits must be balanced with the environmental impacts of providing a connection.
D. Amendments to transportation system plans to modify or reduce proposed stream crossings may impact regional transportation systems.
E. Local FEMA floodplain jurisdictions must continue to require engineering hydraulic analysis of all culvert work.

Recommendation for the Basin:

1. Encourage Metro to amend the RTP to refer to all Goal 5 resources, as well as Title 3 water features, and to include a reference to the other stream crossing standards (e.g., CWS).
2. Develop educational materials to inform the public on the work jurisdictions have accomplished, or intend to accomplish, in their efforts to remove barriers to fish passage.
3. Basin jurisdictions, together with CWS, should continue to coordinate culvert work and efforts to verify the critical basins where safe fish passage is a design issue.

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[10] This preliminary study was the beginning of detailed culvert-by-culvert evaluation by the County, Clean Water Services (CWS), and the Tualatin Basin cities. Jurisdictions have included culvert projects in their adopted capital improvement project lists and have corrected many culverts. CWS maintains a detailed database and meets regularly with the jurisdictions to coordinate corrective projects. Many culverts in the preliminary study were subsequently removed from the barrier list. As of January 2006, progress on improvements to culverts continues throughout the Basin. [Source: Washington County Transportation Engineering]

4. To the extent that this has not already occurred locally, CWS has suggested that local jurisdictions will need to assess the culvert list relative to their own capital programming to determine the order of implementation.
5. In order to facilitate culvert replacement (and keep costs down), Basin jurisdictions could permit culvert replacement and associated enhancement work outright (or in groups of projects) and not require additional land use or vegetative corridor mitigation review for those culvert projects and enhancement projects listed in the Healthy Streams Plan. The Healthy Streams Plan suggests that a regional stream enhancement permit be secured for the District to streamline the permitting process of in-stream and wetland activities. Similarly, CWS should consider amending the vegetative corridor standards to allow for the permitting of groups of projects by public agencies. Basin jurisdictions, together with CWS, should adopt unified stream crossing guidelines, if needed to facilitate these efforts.
6. In fish-bearing streams, investigate automatic gate operators to minimize fish impact while optimizing detention to restore healthy streams and providing improved flood control.

Examples/References:

The County and local jurisdictions have constructed control structures on culverts to provide flow control. State and Federal permitting agencies agree that the "stream-forming" flows are approximately the two-year flow. Detaining storm flows behind these culverts for the developed basin to be released at the undeveloped 2-year flow mitigates stream impacts from existing and proposed development. Opportunities also exist to restrict large event flows with these same structures to provide flood control in the basin. CWS is now studying several sub-basins to optimize this program. The culvert control structures do not restrict local resident fish and wildlife during normal flows. Costs are little more than a standard culvert installation. Maintenance is not increased over the standard installation because these are located in public right-of-way or public easements: long-term operation and effective function is assured. Future modifications to the control structures can be easily completed when needed to address changes in technology, development impacts, or downstream goals. *[Source: Washington County Transportation Engineering]*

References

- Green Streets: Innovative Solutions for Stormwater and Stream Crossings, 1st edition. Metro, June 2002.
- Healthy Streams Plan, Clean Water Services, June 2005.
- Regional Transportation Plan, Metro.

3. Stormwater Management Facility Design

Key Questions	
Helps avoid or minimize impacts?	*Minimize*
Applicable basin-wide or adjacent to resource area?	*Applicable basin-wide.*
New or amended regulations required?	*Yes*
Tool to reduce effective impervious area (EIA)?	*Yes. Subject to UBC, Plumbing Code and local drainage conditions.*
Recommended for basin?	*Yes; however, use of some methods will be limited by site suitability.*

Description of Method:

The *Healthy Streams Plan* found that stormwater was a key factor in stream health and that the management of stormwater quality and quantity influences the ability of a stream to absorb changes in water quality and hydrology. The Plan includes stormwater policy and program refinements for the Basin. It recommends the development and evaluation of a policy that requires "cleaner" runoff from sidewalks, patios, and certain rooftops be retained and infiltrated into the ground where practical. The evaluation would consider soils, long-term effectiveness, maintenance responsibility and cost, as well as other factors. Based on the evaluation of the methods standards and stormwater quantity mitigation credits for effective impervious area, reduction techniques would be developed. These methods could offer several habitat benefits, including preserving existing resource areas and improving water quality (i.e., fish habitat). In addition, local jurisdictions in the Basin can continue to further augment the habitat benefits of the CWS's *Design & Construction (D&C)* standards by, for example, requiring the incorporation of minimum percentages of native plant species within vegetated stormwater facilities.

According to *The Practice of Low Impact Development*, in addition to protecting the environment, when correctly planned for and accommodated, stormwater management systems can satisfy regulatory requirements, act as desirable site design elements, and reduce infrastructure costs. Stormwater treatment can be designed to mimic pre-development hydrologic conditions (particularly

Examples of bioretention in parking lot

for smaller, more frequent storms[11]) through the use of a variety of structural and nonstructural practices that detain, retain, percolate, and evaporate storm water. Alternatives to conventional stormwater systems include infiltration systems such as rain gardens or bioretention areas. These are shallow, topographic depressions filled with engineered soils and vegetation that retain, treat, and infiltrate water. They are commonly located in parking lot islands or within small pockets in residential land uses. Bioretention systems are designed for the temporary storage of rainwater. They provide an opportunity for the water to have increased contact time with soils and plant materials, allowing for the natural systems to filter pollutants and permitting the processes of infiltration, evaporation, and transpiration to occur. They can be used as a buffer to shoreline areas to capture runoff from the home landscape before it enters a lake, pond, or river. Jurisdictions in the Tualatin Basin, in cooperation with CWS, have approved construction of many of these facilities. However, performance is not well documented for this area and these soils and long term evaluations of effectiveness and costs are needed.

Illustration of a rain garden

Filtering systems, such as "Filter Strips," use soils and vegetation to remove pollutants from stormwater for pre-treatment. Filter strips are low-grade vegetated areas that permit sediment to be deposited. Alternative conveyance systems, such as vegetated channels or swales, slow the speed of stormwater and filter pollutants before treatment.[12]

Benefits and Challenges:

A. Low impact development storm water management systems can reduce development costs through the reduction or elimination of conventional storm water conveyance and collection system. However, larger storms may exceed those systems' capacity due to the Tualatin Basin's climate and soils.
B. LID systems can reduce the need for paving, curb and gutter, piping, inlet structures, and storm water ponds by treating water at its source. However, installation and maintenance costs may be

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[11] Bioretention systems may be better suited to accommodate small storm events. Larger storm events may still require some degree of conventional piping and detention systems in addition to low-impact development methods. [Source: Washington County Transportation Engineering]

[12] Filtering systems, such as cartridge filter systems, use filter media cartridges in vaults or above ground systems to filter pollutants out of stormwater. While these systems require yearly maintenance, they require little or no added right-of-way. Construction costs can be slightly more than swales. Maintenance costs are predictable and manageable to budget. Testing and monitoring are easily provided. Within road rights-of-way, road projects have, in the past, constructed underground detention vault systems. These have been designed as necessary to release runoff from impervious surfaces as a designed controlled rate. These are easily maintained and not affected by future utility construction, which would destroy porous pavements or infiltration systems. These continue to be an excellent and cost-effective option where needed. [Source: Washington County Transportation Engineering]

greater than the costs associated with other methods such as piping. Further evaluation of LID systems is needed to verify long-term effectiveness.

C. LID practices remove pollutants from storm water naturally and may help restore a site's pre-development hydrology. Certain practices can help recharge local groundwater tables, reduce domestic water use for lawns and vegetation, and provide habitat for a variety of species.
D. UBC and Plumbing code requirements, as well as local soil conditions, groundwater, adjacent development, future utility construction, and slope stability may limit or prohibit the application of alternative drainage features and designs.
E. Inadequate or poorly maintained systems may fail to perform and may negatively impact adjacent properties. Standards for the construction and maintenance of stormwater management facilities are needed to ensure their effectiveness. An evaluation of existing LID systems within the basin and their effectiveness is the logical first step prior to development of new standards.

Recommendation for the Basin:

1. Adoption of Basin-wide standards for the construction and maintenance of stormwater management facilities would help encourage the use of alternative systems and would ensure fair application of stormwater mitigation credits.
2. Work with building officials to identify UBC and Plumbing code issues.
3. Local jurisdictions in the Basin should consider further augmenting the habitat benefits of the updated D&C standards by requiring the incorporation of minimum percentages of native plant species within vegetated stormwater facilities.

Examples/References:

Clean Water Services Merlo Road Field Operations Facility

Vegetated swales, biofiltration, and "softscaping" at the site was designed to mimic a natural landscape and manage stormwater runoff on site. Instead of underground pipes, catch basins and large detention ponds, there is an integrated system of vegetated swales. Planted with trees, shrubs and herbaceous perennials, the swales provide the stormwater conveyance system. This biofiltration system disperses stormwater on site, controls the rate and volume of runoff, and improves water quality.

All landscaped areas were designed to retain as much rainfall as possible and drain their runoff to swales. Even the runoff from the traditional parking lots flows to swales. The adjacent Nature Park is protected by a 50-foot wide by 600-foot long water quality swale that runs the downstream length of the site. Dispersing stormwater runoff at its source is especially suited for the rainfall patterns here in the Pacific Northwest, where nearly 90 percent of all 24-hour rainfall events are less than 1/2 inch. These small events are easily managed with "softscaping" or

biofiltration landscaping that absorbs rain, recharges groundwater, reduces winter runoff and virtually eliminates summer runoff.

In contrast, typical pipe conveyance systems concentrate and accelerate flows creating artificially high peaks and volumes that negatively impact stream hydrology and aquatic habitat. Warm weather rains can increase water temperature, especially when runoff courses over hot pavement and roofs. Warm water temperatures lower the available oxygen for aquatic organisms, critical for healthy streams and wetlands. Piped systems rush rain downstream, disrupting the natural process of replenishing groundwater.

The facility's vegetated conveyance swales were designed as major or minor, with 2:1 or 3:1 slopes respectively. The depth and width of the swales vary by location. All swales were lined with 6-inches of topsoil, jute mat and a 3-inch layer of 2-inch to 3/4-inch river run rock.
[Source: CWS Slow the Flow ! Designing the Built Environment to Protect Urban Environments brochure]

References

- The Practice of Low Impact Development. US Department of Housing and Urban Development, Office of Policy Development and Research, Contract No. H-21314CA, July 2003.
- Low Impact Development: An Alternative Approach to Site Design. APA PAS MEMO, Asa Foss, May/June 2005.
- Lower Phalen Creek Project, St. Paul, Minnesota http://www.mepartnership.org/sites/LOWERPHALENCREEK/sub_page7.asp

D. Building Design Solutions

Key Questions	
Helps avoid or minimize impacts?	*Minimize*
Applicable basin-wide or adjacent to resource area?	*Applicable basin-wide*
New or amended regulations required?	*Some codes may have to be amended, or new guidelines drafted, to ensure proper placement of disconnected downspouts. Codes may have to be amended to allow green roofs as an element of new development or redevelopment and to account for the structural requirements necessary to support green roofs.*
Tools to reduce effective impervious area (EIA)?	*Yes. May be subject to UBC, Plumbing Code and local drainage conditions.*
Recommended for basin?	*Yes; however, seismic design and the health concerns of moisture within the building (mold) require careful evaluation.*

Description of Method

Incorporating certain elements into the design of new buildings and retrofitting existing buildings can minimize the amount of stormwater runoff leaving a property or site. Elements that can be incorporated into building and landscaping designs that reduce or detain runoff include green roofs, disconnecting downspouts, and rain barrel detention. There are several examples of this approach constructed and operating in Basin.

Brewery Blocks - Block 4 – from BES slide show "Portland Ecoroof Tours"

Photograph-GBD Architects

Green roofs, also known as *vegetated roof covers* or *eco-roofs*, are thin layers of living vegetation installed on top of conventional flat or sloping roofs. Potential benefits associated with green roofs include controlling storm water runoff, improving water quality, mitigating urban heat-island effects, and creating wildlife habitat. Green roofs may be appropriate as an addition to many types of buildings, including commercial, industrial, institutional,

and residential settings. They are particularly effective at controlling runoff on the large roofs typical of commercial and institutional buildings.

Green roofs reduce the amount of stormwater runoff and also delay the time at which runoff occurs, resulting in decreased stress on sewer systems at peak flow periods. Water is stored by the substrate of the green roof and then taken up by the plants, where the water is returned to the atmosphere through transpiration and evaporation. In summer, depending on the plants and depth of growing medium, green roofs retain 70-90% of the precipitation that falls on them; in winter they retain between 25-40%. Because flows from larger storms or longer duration storms will not be fully retained, other systems will likely also be needed.

Green roofs can be designed to achieve specified levels of storm water runoff control, including reductions in both total annual runoff volume (reductions of 50-60% are common) and peak runoff rates for storms. By reducing both the volume and the rate of storm water runoff, green roofs benefit cities with combined sewer overflow (CSO) impacts. Green roofs not only retain the rainwater, but also moderate the temperature of the water and act as natural filters for any of the water that happens to run off. In addition, in urban areas, up to 30% of total nitrogen and total phosphorus released into receiving streams is derived from dust that accumulates on rooftops. Acting as natural bio-filtration devices, green roofs reduce this water contamination. However, to survive the long, dry summers, existing green roofs in Washington County are maintained through irrigation.

The 8,000 square foot green roof system at Clean Water Services Merlo Road Field Operations Facility has drought-resistant plants that absorb rainfall and help insulate the building. Nearly all rain is expected to be retained in warm, dry months. Nearly 80 percent of water is expected to be returned to the atmosphere through evapotranspiration, which will cool the roof and the surrounding air.

Clean Water Services Merlo Road Field Operations Facility
from the *Slow the Flow !* brochure

Disconnecting downspouts from the stormwater system is another way to manage stormwater runoff. Reducing the volume of runoff being diverted directly into municipal storm systems is of primary importance to

those jurisdictions with a combined sewer/stormwater system. Disconnecting downspouts from this system reduces pressure on combination sewer system and helps prevent overflows into streams and rivers. This is the case with the city of Portland, who provides grants and materials to neighborhood associations and other volunteer groups that donate time disconnecting downspouts for interested property owners.[13]

While the Tualatin Basin does not have this type of combined system, allowing stormwater to be absorbed or detained on site instead of being conveyed to a piped system could still play a role in reducing storm water volumes where local conditions support these applications. According to Washington County Transportation Engineering, disconnecting downspouts in some locations in the County has led to flooded crawlspaces. This is a health and safety concern due to mold infestation. The plumbing code requires positive crawlspace drainage, but older homes may not have the required safety system in place.

Another way of dealing with localized stormwater runoff is through a rain barrel or cistern system. This type of rainwater collection system stores rooftop runoff to be used later for activities such as lawn and garden watering, car washing, and window cleaning. A cistern functions similarly to a rain barrel, but has a much greater storage capacity and, in addition to rainwater collection, can be used to filter the water for a wider range of domestic uses. Over the rainy season, even a small roof has the potential to capture enormous amounts of water that otherwise flows down the drain. For example, a typical residence in Portland (36 inches of rain per year) with a 2,000 square foot roof collection area will result in around 35,000 gallons of water captured per year, an average of almost 100 gallons per day.

Rainwater collection and reuse is beneficial to the environment because the stored water would otherwise run off into the storm sewers, bringing pollutants such as oil and grease, bacteria, and nutrients with it. The more rainwater that is reused, the less need there is to chlorinate or chemically treat it before reusing or releasing it back into the watershed. Rainwater harvesting, or capturing rain and storing it for later use, also results in less water use and lower water bills.

Other sustainable or "green" building practices have an indirect benefit on watersheds and habitat areas. Providing efficient landscape irrigation and systems that utilize "low-flow" fixtures to minimize water usage can reduce the impact new development has on the ecosystem.

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[13] NOTE: Depending on specific locations, soils in the Tualatin Basin may not be as suitable for this approach as those in the City of Portland. Also, the City of Portland has building and plumbing codes that allow a degree of flexibility in implementing LID techniquest.

Many of these sustainable practices have been incorporated into building practices associated with the US Green Building Council's national LEED™ (Leadership in Energy and Environmental Design) certification. Portland has developed the country's first supplemental guide to the LEED™ standards. Portland's green building incentive program includes a series of pre-approved innovation credits that reflect the City's goals for mixed use development, construction waste management, alternative transportation, and stormwater management. This program has also centralized local building and zoning code regulations and relevant green building resources into a resource guide for Portland-area development professionals.

Benefits and Challenges

A. Detaining stormwater runoff on site through the use of disconnected downspouts or rain barrels can be accomplished relatively easily and at a low cost. In some cases, these solutions can be easily integrated into site design for new developments, as well as installed by property owners of existing homes/buildings. Careful design and construction is important in order to avoid flooding crawlspaces or impacting adjacent properties.
B. Not all areas are suitable candidates for retaining stormwater on site. It is not advisable to encourage disconnecting from the stormwater system in areas that have poor soil percolation or a high water table.
C. Rain water collection systems (e.g., rain barrels) can freeze and degrade with age, they may require pumps and filter which will need maintenance and care needs to be taken to restrict access from children.
D. Development guidelines or revisions to building codes may be necessary to regulate onsite stormwater conveyance in a manner that does not damage property or pose a threat to neighboring sites.
E. Development guidelines or revisions to building codes may be necessary to ensure structures are strong enough to support proposed green roofs.[14] To construct a green roof on an existing building may require minor or possibly extensive structural upgrades to meet local seismic requirements. Evaluate existing green roofs to verify loading assumptions currently employed and draft or update development guidelines as appropriate.
F. Green roofs are expensive. The initial cost of a green roof can be 30% greater than a conventional roof, despite the fact that long term maintenance (green rooftops prolong the life of a conventional roof) and energy cost savings can offset this cost increase to some degree.

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[14] From "Extensive Green Roofs" (see "Examples/References"): In the United States, green roof designs are generally regulated using existing standards for ballasted roofs. The International Code Council (ICC) code, formerly the BOCA code, used for guidance by many municipal authorities, recognizes roof gardens. It requires that the 'wet weight' of the green roof be treated as an additional dead load. It also supplies live load requirements for maintenance-related foot traffic and for regulated pedestrian access. One limitation of the ICC standards is that it does not specify the testing methods to be used in satisfying the code.

Market fluctuations in the cost of building materials can also be a disincentive to building structures that can support green roofs.

G. The challenge is to explain the costs and benefits, both in financial terms and relating to the environment, of these typically non-traditional building design elements. Education is the key to garnering public acceptance, excitement, and action. Education must include the long-term maintenance requirements.

Recommendation for the Basin

1. The disconnecting of downspouts for existing homes and buildings in the Tualatin Basin should be evaluated and only allowed and encouraged in those areas that have adequate soil percolation and where the risk of private property damage from water-saturated soil is low.
2. Work with CWS to evaluate the need for Basin-wide standards for the construction and maintenance of green roofs and similar facilities, and explore ways to promote green roof building (see examples below). Ensure that building officials are involved to identify UBC and Plumbing code issues.
3. Work with CWS to evaluate, develop, and promote educational and outreach programs to property owners and potential developers regarding methods available to reduce impervious surfaces through design solutions.
4. Utilize the Four-County Building Officials meetings as a forum to review issues or concerns related to the applicability and consistent application of current Building and Plumbing Codes to LID/Habitat Friendly design.

Examples and References

Some examples of ways to promote green roof building include:

- Provide financial incentives. The city of Chicago's Department of Environment and Department of Planning and Development is making a limited number of grants ($5,000 each) to help residential and/or small commercial (less than 10,000 square feet) building owners with a green roof project.
- Make research and resources available. The city of Toronto has created a website that lists specific benefits to the community and a timeline for creating policies to promote "green development standards."
- Lead by example. Multnomah County installed a 15,000 square foot green roof on the Multnomah County Building; Metro installed a 25,000 square foot green roof on the Metro Regional Center building; Clean Water Services installed an 8,000 square foot green roof at the Merlo Road Field Operations Facility.

Resources

- Miller, P.E., Charlie. "Extensive Green Roofs", Roofscapes, Inc., Whole Building Design http://www.wbdg.org/design/greenroofs.php
- Green Roofs for Healthy Cities http://www.greenroofs.net/index.php
- http://www.greenroofs.com
- "Healthy Landscapes", University of Rhode Island http://www.uri.edu/ce/healthylandscapes/tips/5.html
- "Skills for Protecting Your Stream: Retrofitting Your Own Backyard", Center for Watershed Protection, April 2002 http://www.cwp.org/Community_Watersheds/educating_constituents.htm
- City of Chicago Department of Environment www.cityofchicago.org/environment
- City of Toronto http://www.toronto.ca/greenroofs/index.htm
- City of Portland Green Building Resource http://www.green-rated.org/default.asp
- City of Portland, Bureau of Environmental Services, Portland Ecoroof Tours, http://www.portlandonline.com/shared/cfm/image.cfm?id=53988
- King, Jason, ASLA,LEED AP, "Working With Water: Innovative Design Approaches for Stormwater Management", January 3, 2006, , Macdonald Environmental Planning, p.c. http://www.edcmag.com/CDA/Articles/Feature_Article/e79855c9ff298010VgnVCM100000f932a8c0
- Portland Office of Neighborhood Involvement http://www.portlandonline.com/oni/index.cfm?c=28992
- Clean Water Services, "Slow the Flow! Designing the Built Environment to Protect Urban Environments" brochure http://www.cleanwaterservices.org/content/documents/Permit/Slow%20the%20Flow%20brochure.pdf